

ABSTRACT

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The present invention provides apparatus and method for obtaining high dynamic range images using a low dynamic range image sensor. The image of a scene is captured with an image sensor using a spatially varying exposure function. The spatially varying exposure function can be implemented using as an optical mask with a fixed spatial attenuation pattern, or using a controllable attenuation cell array. The captured image after calibration to correct for nonlinear response of the image sensor, is then normalized with respect to the exposure function. Where the exposure function is a fixed spatial attenuation pattern, the normalized image is interpolated to account for pixels that are saturated or blackened. Where the exposure function is implemented using a controllable attenuation cell array, the exposure function is adjusted to minimize the number of saturated or blackened pixels within an area of pixel array exposed through a cell, to maximize the signal-to-noise ratio of the average pixel value, and to maximize the spatial smoothness of the exposure function. Also disclosed is a technique for detailed preserving dynamic range compression of a high dynamic range image for display on a low dynamic range display device. The technique entails applying a smoothing filter to the exposure function used to obtain the high dynamic range image, and then reapplying the smoothed exposure function to the high dynamic range image. Also disclosed is a method for obtaining high dynamic range images by exposing photographic film using a spatially varying exposure function. The exposed film is then developed and scanned to derive an electronic image which is aligned with the exposure function and processed in the same manner as images captured electronically using a fixed exposure function.